

TECHNICAL MANUAL

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General Procedure for the Calibration of Radiation Protection Instrumentation	MD-10215	31	1 of 16
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TECHNICALLY RESPONSIBLE	ECN NO.	EFF. DATE	
Michael Reichard	050005MD	01-20-05	

☒ Denotes change

USE CATEGORY	
A	This procedure must be at the location of the work activity. Each step of the procedure shall be read by the user or designated reader before performance of that step of the activity. If procedure step sign-offs or data taking is required, it shall be accomplished at the completion of the step.

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1. PURPOSE

This procedure provides the method of calibration of the Bicron Analyst when used with the FIDLER detector.

2. SCOPE

The Bicron Analyst is a portable count rate meter that may be used with a variety of GM, proportional or scintillation detectors for the detection of alpha, beta, x-ray or gamma, and neutron radiation. The instrument is a single channel analyzer capable of three modes of operation, which allows energy discrimination and significant background reduction.

In the OUT mode of operation, all signals above the lower level discriminator setting are accepted. In the CH 1 mode of operation, only those signals between the lower and upper level discriminator are accepted and in the CH 2 mode of operation, only those signals above the upper level discriminator are accepted. The instrument has a range of 0 to 500,000 cpm selectable over four linear ranges.

The meter displays count rate on a linear scale of 0-500 and also displays the high voltage (when selected) from 0 to 2.0 kV. The high voltage is adjustable over a range to at least 1600 VDC. The instrument also has a battery check position.

The Analyst operating range is from -20 degrees Centigrade (-4 degrees F) to +50 degrees Centigrade (+122 degrees F) and from 10 to 95% relative humidity.

The instrument has a switch selectable FAST/SLOW response time which varies between one and twenty seconds, depending on the selected scale.

The FIDLER (G5) detector is a large area NaI scintillation detector used for gamma measurements. The optimum operating energy range is between 10 keV and

100 keV. The FIDLER is sensitive to higher energies, but its efficiency drops off rapidly at higher energies. When calibrated with the Analyst, it allows use where energy discrimination or reduction in the effects of background is necessary for accurate measurements. The normal mode of operation with the FIDLER is CH 1. Nominal operating high voltage is 1200 to 1600 volts DC, however, some detectors may operate as low as 600 to 800 VDC. The FIDLER operating range is +39 degrees Fahrenheit to +109 degrees Fahrenheit.

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Calibration consists of:

As Found verification
High Voltage Display adjustment
Discriminator (lower/upper or window) adjustment
Peak centering adjustment
Pulse calibration
FAST/SLOW response test
Audio test

3. SOURCE REQUIREMENTS

Title 10, Code of Federal Regulations, Part 835, *Occupational Radiation Protection*

MD-10348, *Building 45 Operational Procedures Manual*

4. DEFINITIONS

As Found - determination of a condition prior to any adjustment.

CPM - counts per minute.

DPM - disintegrations per minute.

Efficiency - The ratio, expressed as a percentage, of the instrument net reading to the surface emission rate of source under given geometrical conditions.

5. RESPONSIBILITIES

Calibration Technician

Performs maintenance, repair and calibration on the instruments and probes.

6. LIMITATIONS AND PRECAUTIONS

Source handling and use shall be in accordance with MD-10348, *Building 45 Operational Procedures Manual*.

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7. PREREQUISITES

7.1 Planning, Coordination and Preparation

Ensure that the calibration procedure to be used is the most current approved issue.

7.2 Required Documentation

Form ML-9782, Certificate of Calibration

7.3 Tools, Equipment, Parts and Supplies

Appropriate NIST traceable sources

Calibrated Eberline Minipulser (MP-2) with signal cable, or equivalent

Calibrated Oscilloscope with test leads

Calibrated Voltmeter with high impedance probe (1000 megohms or greater) and low voltage test leads

Screwdriver

8. PROCEDURE

8.1 As Found Verification

NOTE: As Found data shall be obtained and recorded unless the instrument arrived damaged and the damage or subsequent repairs corrupted or destroyed any valid data. An entry denoting the possibility of invalid As Found data shall be made on the Certificate of Calibration along with the reason (i.e., "As Found data not obtained (or may be invalid) because instrument arrived damaged. Damage and/or subsequent repairs may have invalidated As Found data.").

8.1.1 Determine the "As Found" high voltage.

- [1] Disconnect the FIDLER detector and connect a calibrated voltmeter with high impedance probe to the detector connector.
- [2] Turn on the voltmeter and turn the Analyst to the HV scale, obtain the "As Found" high voltage and record it on the Certificate of Calibration.

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8.1.2 Other “As Found” data that is required is specified in the following sections of the procedure. Any adjustments made prior to that point will not affect the validity of that particular “As Found” data.

8.2 High Voltage Display Adjustment

8.2.1 Verify the meter reads zero with the instrument turned off. Adjust the mechanical zero, as necessary. Check SAT or UNSAT.

8.2.2 Disconnect (if connected) the FIDLER detector, remove the instrument from the case, and then turn the range switch to the X1000 scale.

8.2.3 Connect the positive lead of a calibrated voltmeter to pin 1 of U6 and the ground lead to pin 1 of the 24 pin connector. Record the voltmeter ID number and Calibration Due Date on the Certificate of Calibration.

8.2.4 Verify the +5V supply reads 5 VDC +/- 0.5 V. Record the +5V reading on the Certificate of Calibration.

NOTE: There is no adjustment possible. Readings outside the acceptable range indicate problems with U6 or other components in the circuitry.

8.2.5 Reconnect the voltmeter positive lead to pin 15 of the 24 pin connector and read the Analyst “Meter Display Voltage, which should be between 0.5 and 3.0 mVDC. Record the “As Found” voltage on the Certificate of Calibration.

8.2.6 If necessary, adjust the ZERO potentiometer (R-31) until the voltmeter reads within the acceptable range. Record the “As Left” voltage on the Certificate of Calibration. Disconnect voltmeter from Analyst.

8.2.7 Turn the Analyst range switch to HV, then connect the voltmeter with the high impedance probe to the detector connector.

8.2.8 Adjust the Analyst high voltage to +1000 VDC, as read on the voltmeter, using the HV potentiometer (R-45).

8.2.9 Observe the Analyst meter displayed high voltage, which should be 1.0 KV +/- 0.04 KV (1 minor division on the HV display scale).

8.2.10 If necessary, adjust the SPAN potentiometer (R-29) until the Analyst meter display reads within the acceptable range.

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8.2.11 Adjust the Analyst high voltage (R-45) to test for Analyst meter linearity at +1600 VDC and at +400 VDC. Acceptable range at 1600 V is +/- 2 minor divisions and at 400 V is +/- 1/2 minor division.

8.2.12 Readjust the high voltage to 600 VDC.

8.3 Discriminator Adjustment

8.3.1 Connect the voltmeter positive lead to the center wiper of the lower level discriminator setting (R-2) and the ground lead to pin 6 of U1. Record the voltage as "As Found".

8.3.2 Connect the voltmeter positive lead to pin 6 of U1 and the ground lead to pin 4 of U1. Record the voltage as upper level discriminator setting "As Found".

8.3.3 Adjust the high voltage to 1400v and turn off the analyst.

8.3.4 Adjust R2 fully counterclockwise.

8.3.5 Adjust R4 fully counterclockwise.

8.3.6 Connect the "+" lead of a voltmeter to the center wiper of R2 and the "-" lead to pin 6 of U1.

8.3.7 Adjust R2 until the voltmeter reads approximately 80 mV (Approximately 4 rotations of R2).

8.3.8 Ensure that the audio is turned on.

8.3.9 Ensure that the Fidler Detector is connected to the analyst.

8.3.10 Turn the Analyzer switch to Ch 1.

8.3.11 Turn the Analyst to the x1 position.

8.3.12 Obtain a NIST traceable Pu 238 source of sufficient activity to read on the x100 or x1000 ranges.

8.3.13 Place the Fidler Detector on the source center.

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8.3.14 Adjust R4 clockwise until the Analyst begins to respond to the source activity.

NOTE: You should hear several clicks, but be careful not to adjust meter deflection above 100cpm.

8.3.15 Adjust R2 slowly counter clockwise. It may be necessary to vary the ranges as the source counts increase. See Note.

NOTE: The Analyst should begin to respond to the source activity. At this point instrument noise may occur, therefore after every rotation of R2 remove the source from the detector to check for noise. If the meter response continues noise is present. You must back R2 off until the noise response drops out. If noise is not present continue to adjust R2 occasionally checking for noise. The maximum amount of noise should not exceed 300cpm.

8.3.16 Adjust R2 until the source activity is maximized and the instrument noise is minimized.

8.3.17 Connect the voltmeter positive lead to the center wiper of the lower level discriminator setting R2 and the ground lead to pin 6 of U1. Record the voltage as "As Left".

8.3.18 Connect the voltmeter positive lead to pin 6 of U1 and the ground lead to pin 4 of U1. Record the voltage as the "As Left" upper level discriminator setting.

8.4 Pulse Calibration

8.4.1 Connect a calibrated MP-2 to the detector connector, then adjust the output to -1.5V +/- 0.15V with a pulse width of 10 microseconds.

NOTE: The MP-2 has a negative output pulse and a pulse width of 10 microseconds. If an equivalent pulser is used, ensure it meets or is set up to meet the negative pulse output pulse at the correct width.

8.4.2 Record the MP-2 ID number and Calibration Due Date on the Certificate of Calibration.

8.4.3 Turn the Analyst mode to OUT and the range switch to X1000.

8.4.4 Set the MP-2 to provide a 400,000 cpm output.

8.4.5 Observe and record the "As Found" reading on the Certificate of Calibration.

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- 8.4.6 Set the MP-2 to provide a 100,000 cpm output.
- 8.4.7 Observe and record the “As Found” reading on the Certificate of Calibration.
- 8.4.8 Repeat the test on each of the other ranges using the following MP-2 outputs and record each of the “As Found” values on the Certificate of Calibration.

Inst. Range	MP-2 Output	Acceptable Analyst Meter Reading			
X1000	400,000	360,000	-	440,000	
X1000	100,000	90,000	-	110,000	
X100	40,000	36,000	-	44,000	
X100	10,000	9,000	-	11,000	
X10	4,000	3,600	-	4,400	
X10	1,000	900	-	1,100	
X1	400	360	-	440	
X1	100	90	-	110	

- 8.4.9 Adjust any scale that did not meet the acceptable meter reading, then record all “As Left” values on the Certificate of Calibration.
- 8.4.10 Turn off and disconnect the MP-2.

8.5 Peak Centering Adjustment

- 8.5.1 Connect the FIDLER detector, then turn the Analyst mode to CH 1.
- 8.5.2 Place the FIDLER on a NIST traceable Pu-238 source. Record the source ID, Isotope and Activity.
- NOTE:** A different isotope source may be used if the Analyst is to be used to survey for it.
- 8.5.3 Lower the high voltage until the count rate decreases significantly, then begin slowly raising the high voltage until the count rate reaches a maximum and begins to decrease.
- 8.5.4 Carefully reduce the high voltage until the count rate is at maximum.
- 8.5.5 Record the maximum reading on the Certificate of Calibration.

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8.5.6 Measure and record the “As Left” high voltage on the Certificate of Calibration. Remove the source.

8.5.7 Turn the Analyst mode to CH 2.

8.5.8 Determine average background.

☒ 8.5.9 Using source ID# 5589-MIX-A & B or 5590-MIX-A & B determine average source count in CH-2.

8.5.10 Document both background and source count in comment section of both cal certificate and cal sticker.

8.6 Fast/Slow Response Test

8.6.1 Disconnect the fidler and turn the AUDIO on during this test to accomplish part of the Audio test delineated in Section 8.8 concurrent with this test.

8.6.2 Connect the Minipulser and turn the instrument response switch to FAST, channel to out and the range switch to X1000.

8.6.3 Adjust the MP-2 to provide a 400,000 cpm output.

8.6.4 Observe the response time which should be rapid (less than 1 second).

8.6.5 Adjust the MP-2 for a 100,000 cpm output, then turn the instrument response switch to SLOW.

8.6.6 Adjust the MP-2 to provide a 400,000 cpm output and observe the response time, which should be much slower than in Step 8.7.4 (approx. 1 second).

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- 8.6.7 Repeat the test on each of the other ranges using the following MP-2 outputs and observe the instrument response times listed.

NOTE: Instrument should read 90% of final reading within the following response times.

Inst. Range	MP-2 Output		Response Time	
	High	Low	FAST	SLOW
X1000	400K	100K	< 1 sec	1 sec
X100	40K	10K	< 1 sec	2 sec
X10	4K	1K	1 sec	8 sec
X1	400	100	12 sec	20 sec

8.7 Audio Test

- 8.7.1 Verify the audio response of the instrument during performance of the FAST/SLOW Response Test.
- 8.7.2 With the MP-2 providing a 400 cpm input to the instrument, turn the selector switch to BAT and HV positions and verify that the audio is silent.
- 8.7.3 Turn the AUDIO switch off, change to X1 range, then adjust the MP-2 output to 800 cpm.
- 8.7.4 Verify that a continuous tone is heard after Analyst pegs full scale.
- 8.7.5 Change to the X10 range, adjust the MP-2 output to 8,000 cpm, and verify the continuous tone.
- 8.7.6 Change to the X100 range, adjust the MP-2 to 80,000 cpm, and verify the continuous tone.
- 8.7.7 Change to the X1000 range, adjust the MP-2 to 800,000 cpm, and verify the continuous tone. Turn off the Analyst.

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8.8 Re-assembly

8.8.1 Mark all the potentiometers to prevent movement and indicate their position after all adjustment.

NOTE: This may be done with “White Out” or colored nail polish.

8.8.2 Set the RESPONSE switch to SLOW, the mode switch to CH 1 and the AUDIO switch to OFF.

8.8.3 Check the battery condition and replace if necessary.

8.8.4 Reinstall the instrument in the case.

8.8.5 Complete the Certificate of Calibration and a Calibration Sticker for the instrument.

8.8.6 Submit the Certificate of Calibration for processing and filing.

9. REFERENCES

MD-10348, *Building 45 Operational Procedures Manual*

Technical Manual for Bicron Analyst Portable Analyzer

10. RECORDS

Form ML-9782, Certificate of Calibration

11. ATTACHMENTS

Attachment 1 Analyst Face View

Attachment 2 Analyst Interior Left and Right Side Views

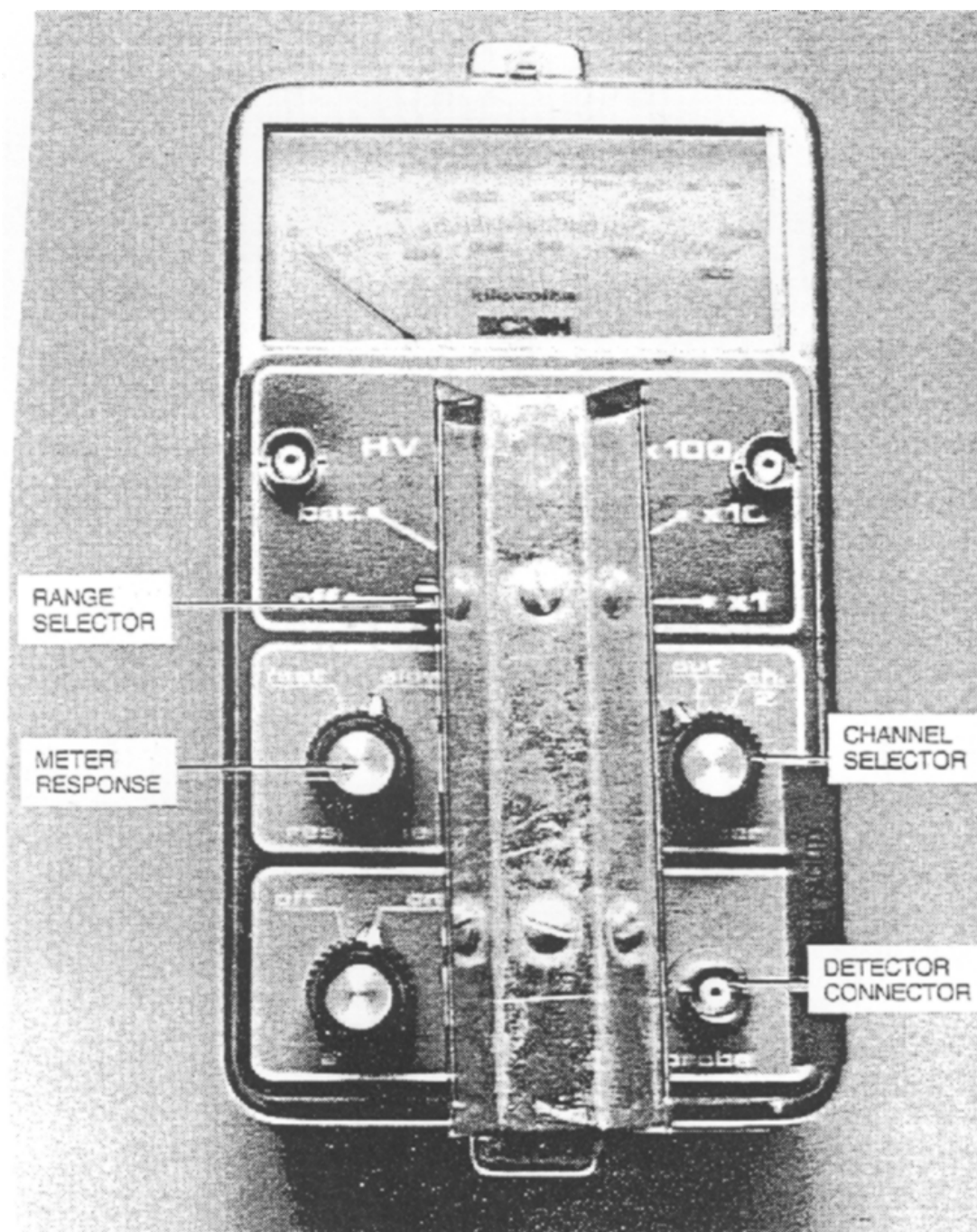
Attachment 3 Analyst Main Board Layout

Attachment 4 Analyst Circuit Schematic

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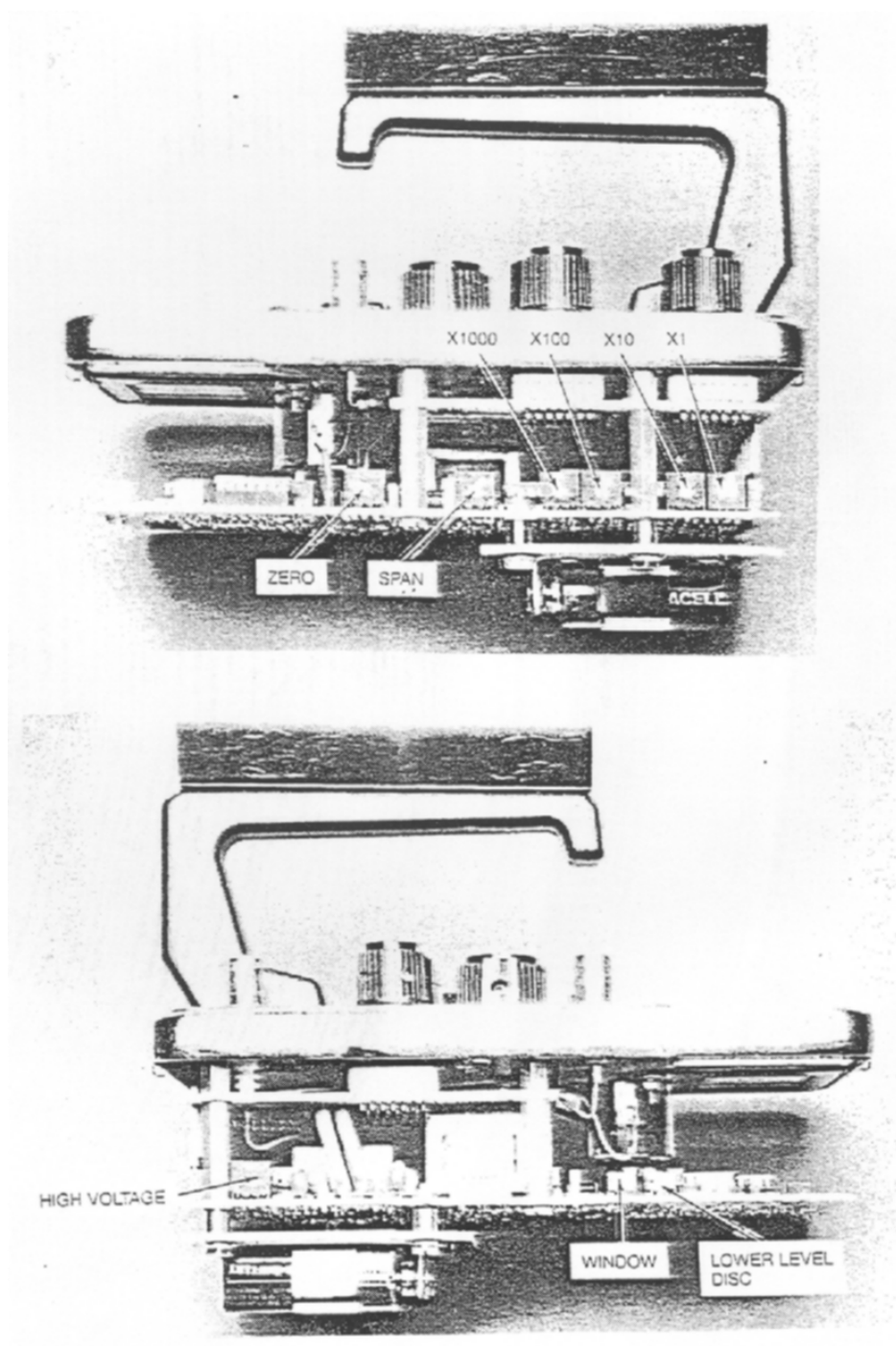
Attachment 1 - Analyst Face View



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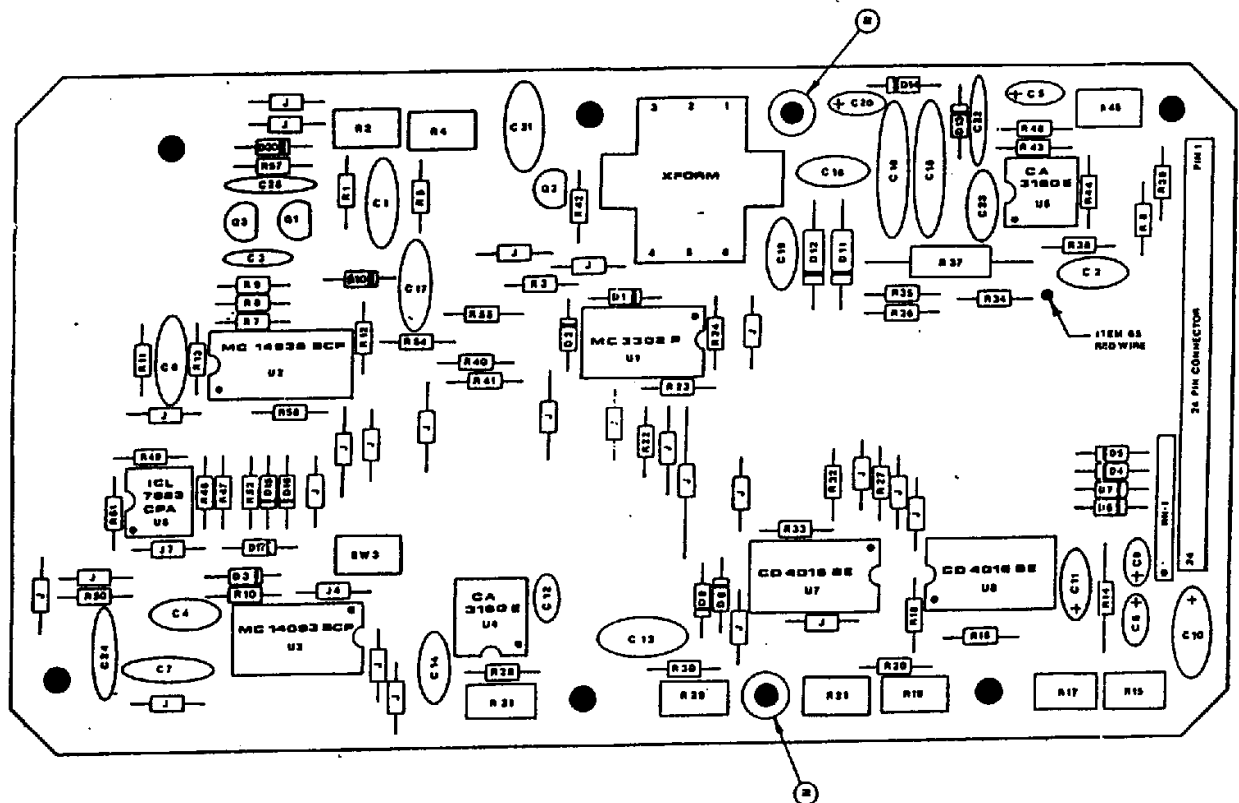
Attachment 2 - Analyst Interior Left And Right Side Views



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Attachment 3 - Analyst Main Board Layout



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Attachment 4 - Analyst Circuit Schematic

